UAS Integration in the NAS Project
KDP Follow-On Briefing

Laurie Grindle
Project Manager, UAS Integration in the NAS Project

February 4, 2014

KDP Follow-on Decision Request

- KDP Follow-on
  - Addresses the actions received at KDP by presenting the following:
    - Assessment of what's required for a more robust TC6
    - Identification of the right balance for partnership, funding, and value proposition for TC4
    - TC5 redesign to include an Autonomy focus
    - Coordination with ASP for development of plan defining the path forward for any needed LVC-DE enhancements

- Decision the Project is seeking today
  - Approval of TC4, TC5, and more robust TC6
  - Approval to proceed with the path forward toward identifying future LVC-DE enhancements

KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

Project Goal, Research Themes, & Technical Challenges

Goal: Provide research findings to reduce technical barriers associated with integrating Unmanned Aircraft Systems into the National Airspace System utilizing integrated system level tests in a relevant environment

Research Theme 1: UAS Integration - Airspace integration procedures and performance standards to enable UAS integration in the air transportation system

Research Theme 2: Test Infrastructure - Test infrastructure to enable development and validation of airspace integration procedures and performance standards

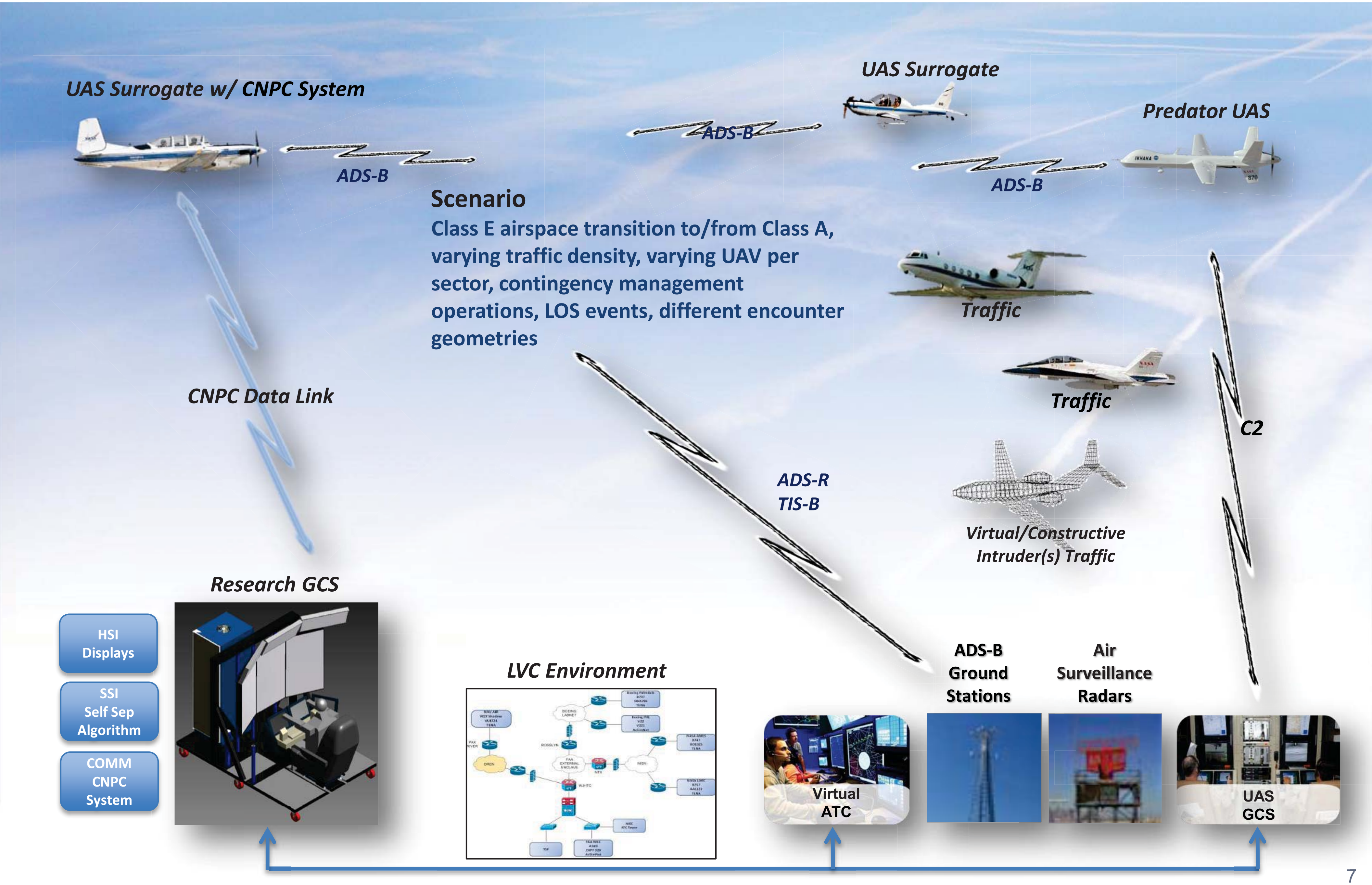
KDP Results & Action Summary

- Approved to proceed with the execution of Technical Challenges 1, 2, 3, and 6
- Ensure TC6 is sufficiently “robust” to execute with a high level of confidence
- Execution of TC4 and TC5 are pending approval following the completion of the following actions:
  - Redesign TC4 and TC5 and descope
    - If TC4 remains in the portfolio, need to reduce the NASA costs (1 study) AND add a funded partnership
  - Since TC5 matches well with the future work vs. the immediate needs, consider aligning TC5 with future autonomous work
- Consider Center workforce balance when making the above decisions
- Come back prior to baseline review to brief the redesigned TC4, TC5, and TC6
- LVC-DE Enhancements Secondary Action
  - After ensuring that there are sufficient funds to meet current TC6 objectives, redesign of TC4 and TC5, if additional funds are available in FY14 and FY15, look at what mods could be made to the LVC-DE to be of better use for future autonomous work
  - The focus should be on setting up an environment that brings in partners for future work.
  - External partner
    - Look at the possibility of establishing a relationship with ZeeAero or Aurora

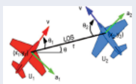
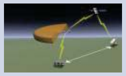
KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

LVC Supporting Test Elements



Integrated Test Progression

Test Element	IHITL [FY14]	FT3 [FY15]	FT4 [FY16]
GCS 	• Research Ground Control Station (RGCS) with traffic displays and alerting logic	• RGCS with UAS Surrogate (T-34C) Command and Control	• RGCS with UAS Surrogate (T-34C) C2 • Multiple GCSs
SAA Algorithms 	• Self separation, idealized sensor data	• Integration of collision avoidance into surrogate or simulated	• CA algorithm integrated into UA partner or self separation only
UAS 	• Simulated	• UAS Surrogate (T-34C)	• UAS Surrogate (T-34C) • SAA equipped UAS
Sensor 	• Simulated	• Simulated on board UAS Surrogate	• On board SAA, partner or simulated
Surveillance  	• Modeled mixed ADS-B and radar	• ADS-B/TIS-B, modeled and real	• ADS-B/TIS-B, modeled and real
Traffic 	• Simulated	• UAS/UAS Surrogate • Simulated Traffic	• UAS/UAS Surrogate • Live Traffic • Simulated Traffic
Command and Control Link 	• Modeled	• Prototype Equipment – single aircraft	• Prototype Equipment – multiple aircraft
Test Scope	Simulation sessions over an 8 week period	Multiple flights over an 8 week period (~30 flight hours)	Multiple flights over an 8 week period (~30 flight hours)

TC6: Integrated Test and Evaluation

Technical Challenge Elements	TWPs	Technical Work Package Name	NASA Center
TC6-1 Test Environment	ITE-LVC	Live Virtual Constructive (LVC) Distributed Test Environment	ARC/DFRC
TC6-2 Test Execution	ITE-IHITL	Integrate Technology and Execute IHITL	ARC/DFRC
	ITE-FT3	Integrate Technology and Execute FT3	ARC/DFRC
	ITE-FT4	Integrate Technology and Execute FT4	ARC/DFRC

- Integrated Tests
  - Exercise technologies, concepts and procedures developed by the subprojects (TC1, TC2 & TC3)
  - Complex, relevant environment
  - Collect data to inform and validate MOPS

- The role of the IT&E subproject is to build up the relevant environment, lead test planning and execution, manage the integrated test configurations, and ensure test safety and efficiency

Process to Ensure TC6 Robustness

What we set out to do

- Reassess requirements, develop a high fidelity schedule, and review risks and mitigations to meet research needs for Integrated Events

What we did

- Developed High Fidelity Schedule
  - Examined the project IMS for adequate detail and dependencies to ensure the project can successfully execute the Integrated Events
  - Generated high confidence resource loaded schedules for IT&E
- Reassessed TC6 Requirements
  - Examined TWPs requiring integrated tests to ensure research needs and approach were consistent with existing IT&E requirements
  - Developed architecture description to identify all necessary requirements and ensure ICDs are generated
- Reviewed Risks and Mitigations
  - Examined TWP activities to evaluate their utilization as IT&E risk mitigations (e.g. test scenarios, LVC connections, technology development, simulations, and other test activities)
  - Conducted comprehensive risk reviews and generated mitigations for each risk
  - Created/identified new risks and mitigations to address findings from requirements and schedule reviews

Why TC6 is More Robust

- Developed high confidence resource loaded TC6 schedule
  - Reduced schedule risk
  - Identified necessary staff to execute
  - Ensured subproject activities are linked
  - DFRC Independent Assessments
    - Prior to KDP, DFRC conducted an independent assessment of IT&E concluding the project was at a Medium+ risk based on dependencies not being identified or developed
    - After reviewing the Post-KDP IT&E updates the Risk was re-assessed as Low+
- Confirmed TC6 requirements meet research needs for integrated events
  - Existing requirements validated
  - Additional requirements identified
- Confirmed residual risks are acceptable
  - Identified high risk areas and have implemented associated mitigations
- Project reserves have been allocated to account for identified risks and mitigations

High Confidence TC6 is Executable

Schedule Assessment

- Major Findings & Results:
  - Need to develop high confidence, resource loaded schedules for IHITL, FT3, and FT4
  - Missing Dependencies within all subproject schedules identified and need to be assessed against the start date of the Integrated Events
  - Relevant Risks were not being tracked as part of the schedule
  - Identified single point failure of the GRC T-34 aircraft used to host CNPC radio in all flight tests
  - Parallel efforts of integrated test activities identified need for additional resources for test support activities [WYEs added]
  - Need for schedule fidelity for all TWPs (in work for baseline review)

TC6 Impacts	
Schedule	High fidelity schedules developed to include deliverable dates which were communicated to each subproject. Track relevant risk mitigations.
Technical	Higher confidence technical objectives will be achieved

Example (FT-3) to show fidelity

Flight Test 3 Task	Projected Comp. Date
Begin FT-3 Requirements/Planning	8/15/14
FT-3 Delta SRR	9/29/14
Obtain Other Sub Project Inputs for SWRR ("Checklist" task)	10/31/14
FT-3 Delta SWRR	11/18/14
Obtain Design/ICD Inputs from other Sub Projects ("Checklist" task)	12/9/14
Incorporate Other Sub Project Inputs for FDR ("Checklist" task)	1/14/15
Obtain FDR Documentation Required from other Sub Projects ("Checklist" task)	1/26/15
FT-3 Final Design Review (FDR)	3/10/15
Receive Final Experimenters Scenarios Required for Final Flight Test Plan ("Checklist" task)	3/17/15
Receive Final FT-3 Software Elements from Other Sub Projects ("Checklist" task)	3/30/15
Baseline FT-3 Test Plan (L2 milestone)	3/31/15
Conduct CCB to Freeze FT-3 Configuration	4/9/15
Obtain and Baseline Final Software Versions (Internal & External) ("Checklist" task)	4/9/15
Delivery of CNPC to Dryden	4/28/15
Conduct RGCS Connectivity Test with T-34 at GRC	5/14/15
Deploy GRC T-34 to DFRC (Aircraft needed at DFRC on this date)	5/28/15
Obtain Other Sub Project Inputs for TRR/Tech Brief ("Checklist" task)	6/2/15
Conduct Combined Systems Test (CST)	6/8/15
FT-3 Tech Brief	6/24/15
Begin FT-3 Flight Test Series	6/27/15
Complete Flight Test with Controllers as Subjects	7/28/15
Complete Flight Test with Pilots as Subjects	8/27/15
Flight Test IT&E Data Analysis Complete	9/10/15
Complete Flight Test 3 Flight Test Report for Review	9/30/15
Obtain UAS/NAS Project Office Review and Comments	10/7/15
Obtain ARD Review/Comments	10/23/15
Submit Flight Test 3 Flight Test Report to ISRP (L1 Milestone)	10/27/15

IT&E FT-3 Preparation for SRR

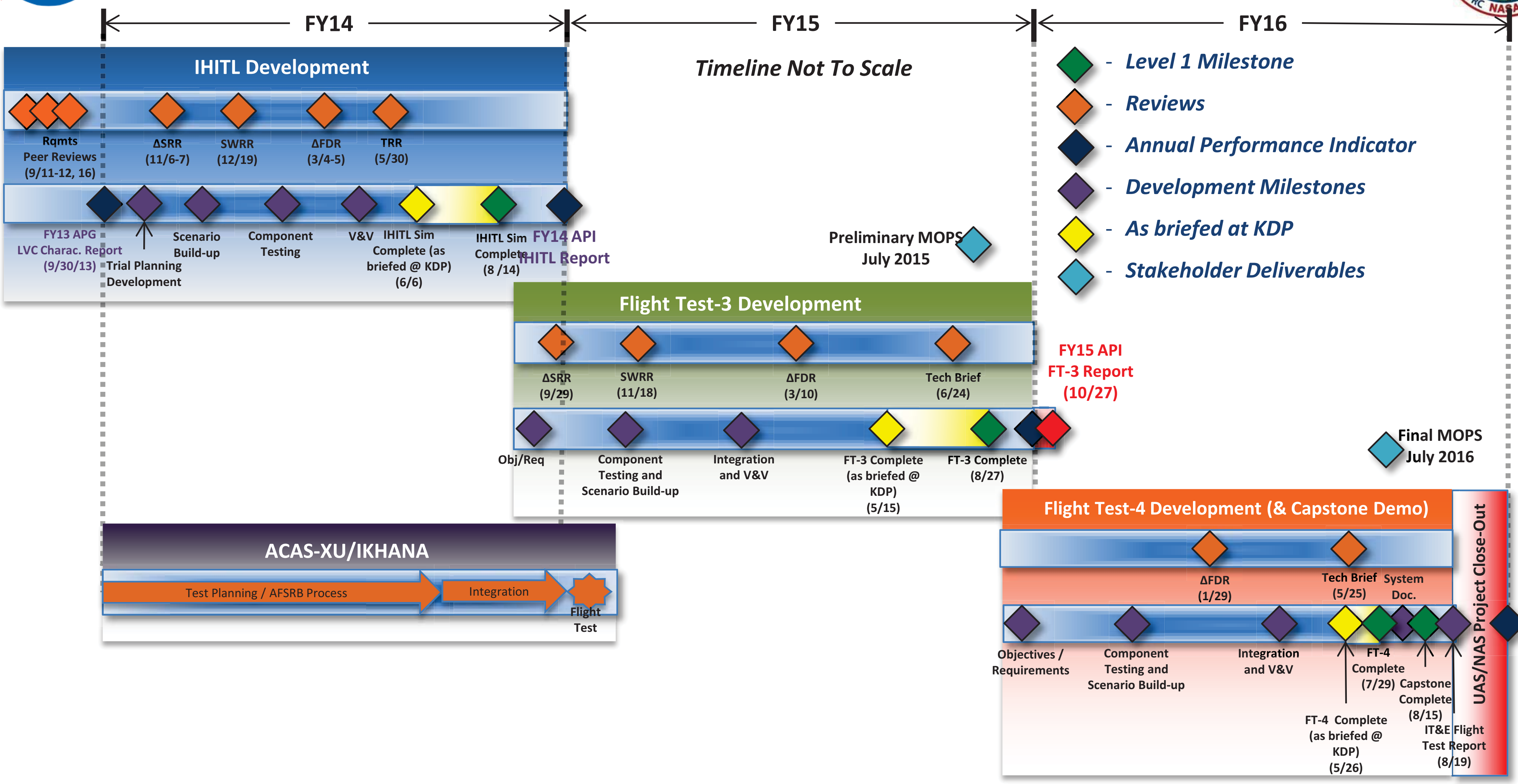
IT&E FT-3 Preparation for FDR

IT&E FT-3 Integration

IT&E FT-3 Flight Test

IT&E FT-3 Reporting

IT&E Project Life Cycle – Phase 2



Additional work planned as part of baseline development

- Low risk to execute the documented requirements, however, does not align with Project/Program milestones
- Looking at options to pull the FT3 and FT4 schedules to the left
- Present updated schedule at Baseline Review

Technical Review Assessment

- Major Findings & Results:
  - The project requirements are not fully developed
    - There is a potential need for an aircraft equipped with current generation Traffic Alerts and Collision Avoidance System (TCAS II) to serve as an intruder
    - There is a potential need for data from an aircraft carrying multiple sensors (radar, TCAS II, and ADS-B)
  - Additional personnel required to document the architecture and support the resultant systems engineering activities [WYEs added]

TC6 Impacts	
Schedule	Impacts will be incorporated in baseline IMS
Technical	High confidence that all research needs will be documented requirements at baseline review

Risk Assessment

Major Findings & Results:

- Need for refined risk, mitigations, and process
  - Risk manager assigned to IT&E (WYE resource absorbed by existing IT&E FY14/15/16 budget)
  - IT&E initiated weekly risk working group meetings
- Distributed test environment requirements for [IHITL, FT3, FT4] requirements not defined (Risks 5.1.6, 5.1.7, & 5.1.8)
- Required assets for [FT3, FT4] not available during test period (Risks 5.1.10 & 5.1.11)
- The T-34 (UA Surrogate) for FT3 and FT4 may not be available (Risk 5.1.17)
- Inability to achieve TCAS II self-separation IHITL objectives due to lack of an IT security authority to operate (Risk 5.1.15)
- Validation of SAA concept requires actual implementations of SAA capabilities to address real world uncertainties (Risk 4.1.8)

TC6 Impacts	
Schedule	Mitigations are reflected in the IMS
Technical	Mitigations do not impact technical objectives

Risks Addressing Robustness

Risk Matrix

LIKELIHOOD	1	2	3	4	5
5					
4					5.1.15
3			5.1.6 5.1.7 5.1.8 5.1.10 5.1.11 4.1.8		
2					
1					5.1.17
	CONSEQUENCE				

Risk ID	TC	L x C	LxC @ ECD	Approach (M,W,A,R)	Risk Title
5.1.15 (T)	TC6	4x5	1x3	M	Inability to achieve TCAS II Self-separation IHITL Objectives due to lack of an IT Security Authority to Operate (ATO)
5.1.6 (T)	TC6	3x3	1x3	M	Distributed Test Environment requirements for IHITL not defined
5.1.7	TC6	3x3	1x3	M	Distributed Test Environment requirements for Integrated Flight Test 3 (FT3) not defined
5.1.8	TC6	3x3	1x3	M	Distributed Test Environment requirements for Integrated Flight Test 4 (FT4) not defined
5.1.10	TC6	3x3	1x3	M	Required Assets for Flight Test 3 (FT3) not available during test period
5.1.11	TC6	3x3	1x3	M	Required Assets for Flight Test 4 (FT4) not available during test period
4.1.8	TC1	3x3	2x2	M	Sense and Avoid Sensor Suite Availability
5.1.17	TC6	1x5	1x3	M	The T-34 (UA Surrogate) for FT3 and FT4 may not be available

Criticality
High
Med
Low

Approach
M - Mitigate
W - Watch
A - Accept
R - Research

(T) Indicates a Top Risk

KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

TC4: Certification and Safety

Technical Challenge Element	*TWPs*	*Technical Work Package Name*	*NASA Center*
Certification & Safety	CERT-Rest	Restricted Category Type Certification	LARC/ARC

- KDP Action: Redesign TC4 to reduce the NASA costs (1 study) and add a funded partnership

- The steps taken to address the actions are:
  - Re-evaluated the full suite of community needs
  - Determined the most beneficial case study
  - Developed a partnership plan with the University of North Dakota
  - Developed a plan that makes the most significant impacts to the community

- The plan the project has developed in response to the action will lead to more beneficial products to the UAS community (NASA, FAA, academia, and industry) for less NASA resources

TC4: Certification and Safety Community Needs Addressed

- The FAA, ARC, and JPDO have all documented a need for airworthiness certification and safety standards and requirements to operate UAS commercially in the NAS (specifically for UAS > 55lbs or beyond line of sight)
- The need for pathfinder activities to assist in generating design criteria for fixed wing, airships, and rotorcraft was documented in the ARC Implementation Plan, and then adopted by the FAA Roadmap
- The FAA has also released a requirements document decomposing the CONOPS with several certification and safety requirements referencing:
  - Specific design and performance criteria (e.g., "standards for reliability of critical systems and functions") for different UAS types and operations
  - Development and/or adaptation of airworthiness requirements specific to UAS on which to base type certification
  - Requirements for civil UAS operators to obtain an appropriate airworthiness certificate from the FAA before operating in the NAS

Strong Documented Community Need

Importance of UAS Agriculture Mission

- Indicators related to UAS market consistently show agriculture as more than 10x more beneficial than the next business case (public safety / disaster response)
  - A July 2013 Frost and Sullivan Webinar purported that 30,000 UAS will be sold for agricultural purposes after the first year UAS are allowed to operate in the NAS. That will grow to nearly 590,000 in 7 years.
  - Precision agriculture projected as a $76B industry with 100,000 jobs by 2025
  - UAS can be operated for significantly less $/hr than manned aircraft

- Manned mission accident rates obtained from AOPA Safety Institute illustrate the high level of risk to manned pilots conducting agricultural related missions
  - 7.4 accidents per 100,000 hours; 7.2 fatal accidents per year (of 1.28 million total hours)
  - When evaluated using FAA's value of injury and value of statistical life ($200 thousand for injury, $9.1 million for fatality), this equates to a total safety consideration of $170.2 million

- Japan is currently operating UAS for agriculture and studies indicated a market size of 165,000 unit sales per year.

The Yamaha R-Max operates on a Lease-only basis at $22 per operating hour

Ground proximity and power lines present serious issues to manned pilots

Other countries have proven that agriculture missions are prime candidates for domestic UAS Operations

Why NASA?

- Companies that build small/mid sized UAS can not justify a business case without understandable certification regulations, and do not generally have the resources or expertise to conduct certification/safety analysis
- A type certification and safety case analysis developed by a specific company will not be broadly applicable to the rest of the UAS industry
- FAA is responsible for regulating the industry and ensuring safe operations, and does not generally endorse choosing subsets of the market to endorse without legislation (sUAS rule and Test Sites)
- Traditionally NASA's role has been to support the FAA and industry in solving aircraft safety (standards/procedures/processes) and certification challenges for new technologies
- NASA is uniquely positioned with expertise and experience necessary to execute the work of TC4 and to transition the results broadly into the FAA and commercial UAS industry

NASA is uniquely qualified to enable an industry versus enabling an applicant

Partnership with University of North Dakota (UND)

- Certification team has been actively working with UND to refine the original Phase 2 proposal to comply with guidance from KDP
- The North Dakota Department of Commerce is dedicated to enable UAS and benefit their sugar beet industry, and also brings other agriculture companies to the partnership
- UND is part of the North Dakota Department of Commerce UAS Test Site team whose research focus is “to develop UAS airworthiness essential data and validate high reliability link technology”
- UND brings expertise and connections with industry wanting to use mid-sized UAS (e.g., precision agriculture industry)
  - Complements NASA team strengths in certification and safety substantiation methods
- UND’s expertise will be leveraged to deliver the CONOPS, business case, and UAS platform/data necessary to maximize the realism of type certification basis and safety substantiation

NASA/UND collaboration greatly increases the realism and robustness of the type certification study

TC4: Original vs. Re-Scoped Proposals

Original Phase 2 Proposal (KDP)	Intermediate Project Resource Evaluation	Re-scoped Phase 2 Proposal (KDP Follow-on)
Approach:	**Approach**:	**Approach**:
• 2 type certification case studies – 2 argument-based safety cases	• 1 type certification case study – 1 argument-based safety case	• 1 type certification case study – 1 argument-based safety case
• NASA defined CONOPS	• NASA defined CONOPS	• Industry defined CONOPS
• NASA defined UAS design (virtual)	• NASA defined UAS design (virtual)	• Real UAS design that meets CONOPS
• Safety metric tracking		
Benefit to the Community:	**Benefit to the Community**:	**Benefit to the Community**:
• Public awareness of design/ performance requirements • Broad applicability to 2 aircraft classes	• Public awareness of design/ performance requirements • Broad applicability to 1 aircraft class	• Public awareness of design/ performance requirements • Broad applicability to 1 aircraft class • Increased readiness for cert processes (Industry/FAA)

TC4: Certification and Safety Overview

Description: Conduct case study to develop safety substantiation data for a type certificate (restricted category) for a UAS platform performing a commercial precision agriculture operation

Objectives → Approach → Deliverables

Objectives:

- Develop UAS design and performance criteria necessary for airworthiness certification (restricted category) for a UAS platform for precision agriculture
- Evaluate an alternative approach for developing safety substantiation data for a UAS

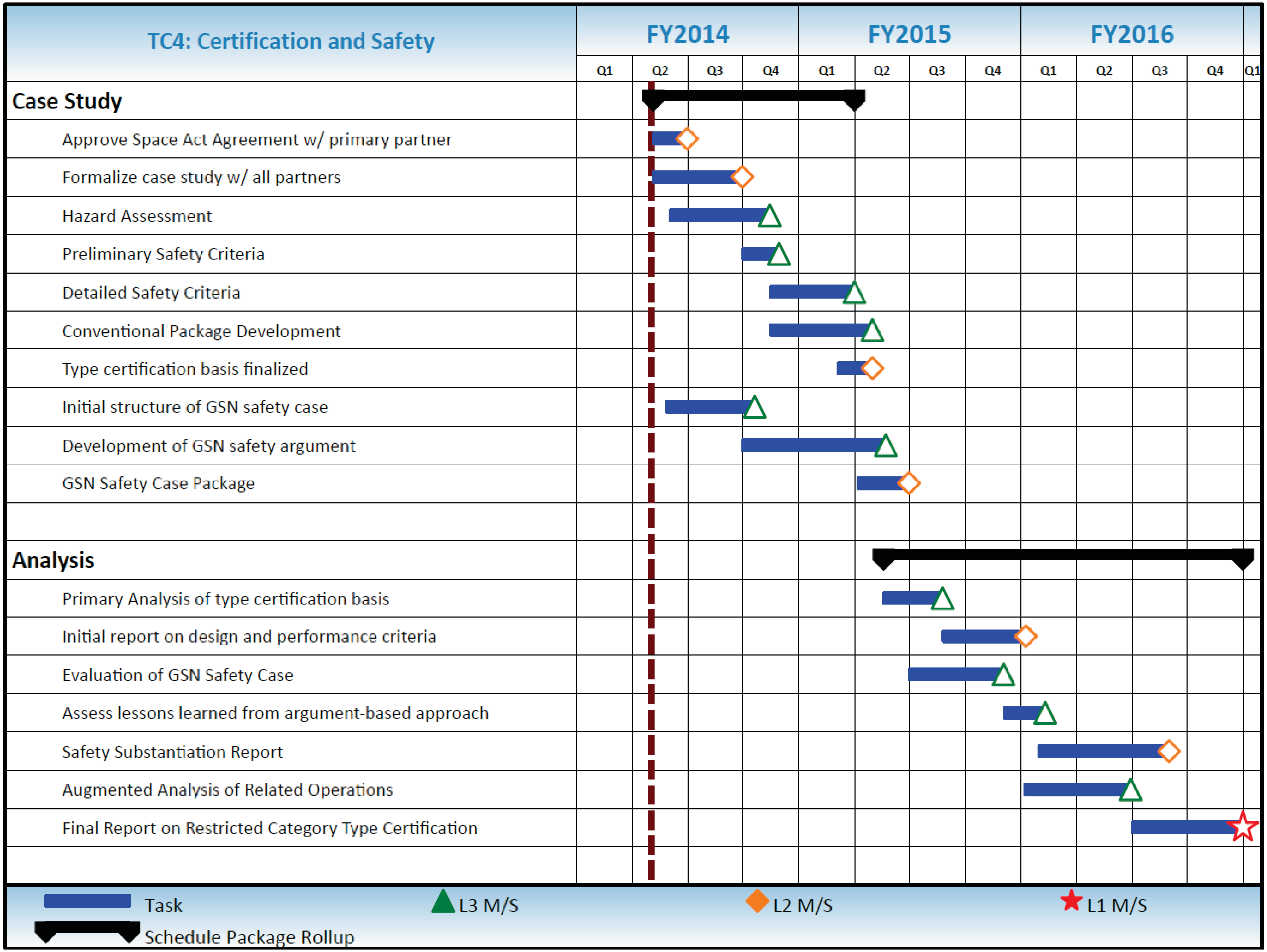
Approach:

- Determine airworthiness requirements for a UAS doing a precision agriculture application
  - Define the CONOPS and business case for an unmanned precision agriculture application (UND)
  - Develop type design requirements and operational limitations for that UAS
  - Analyze safety data to discern generalized applicability to other UAS
  - Capture safety substantiation data using two different approaches to study suitability

Deliverables:

- UAS design and performance criteria report
- Safety Substantiation report
- Report on Applicability to Other UAS and Other Operations

UAS-NAS TC4: Certification & Safety



KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

TC5: Air Transportation System Interoperability

Technical Challenge Element	*TWPs*	*Technical Work Package Name*	*NASA Center*
Autonomy	ATSI-Auto	Levels of Automation/Automation Roadmap	ALL*
NextGen	ATSI-NextG	Application of NextGen Technologies for UAS	ARC
sUAS	ATSI-sUAS1	sUAS Support to Initial Rulemaking	DFRC/LaRC

* Note: The DPMfs will support this effort in conjunction with the Autonomy Technical Lead

Summary of Changes Since KDP

KDP Action: *Redesign TC4 and TC5 and descope*

- Since TC5 matches well with the future work vs. the immediate needs, consider aligning TC5 with future autonomous work

Post KDP activities to address the action:

- TC5 proposals presented during KDP were three standalone activities all related to interoperability within the Air Transportation System
- The Project found a logical way to link the outputs from the three TC5 activities in a manner to reduce barriers for UAS access while simultaneously advancing future autonomy related research

ATSI-Auto	No content changes; although TWP effort is at the forefront of ensuring NASA's Autonomy work will be relevant
ATSI-NextGen	Evaluates autonomy-related technologies and procedures that may allow new types of UAS missions and applications (e.g. ICAST Design Reference Missions)
ATSI-sUAS1	Establishes a partnership with the US Fish and Wildlife Service (DOI) focused around sUAS fire detection capabilities Leverage this partnership to conduct high-value sUAS research on increased levels of autonomy leading to robust scenario development for future autonomy research (e.g. under CTD Project's UAS Traffic Management)

- Descoped NextGen and sUAS TWPs

TC5: Air Transportation System Interoperability Community Needs Addressed

- Data and information collected in a relevant environment is needed to support the development of rules and regulations to enable sUAS operations in the NAS beyond what is envisioned as part of the pending FAA's sUAS rule
- There is a need to examine new procedures, technologies, and roles/responsibilities of NAS users and air traffic service providers expected under the NextGen umbrella
- There is a need to evaluate the benefits increased autonomy will have for integration of UAS into NextGen
- There is a need to evaluate autonomy-related technologies and procedures that may allow new types of UAS missions and applications
- A UAS Automation Roadmap (UAR) needs to be developed that evaluates the use of increasing levels of automation within the context of FAA NextGen infrastructure and stakeholder R&D capabilities

TC5: Air Transportation System Interoperability Proposed Changes

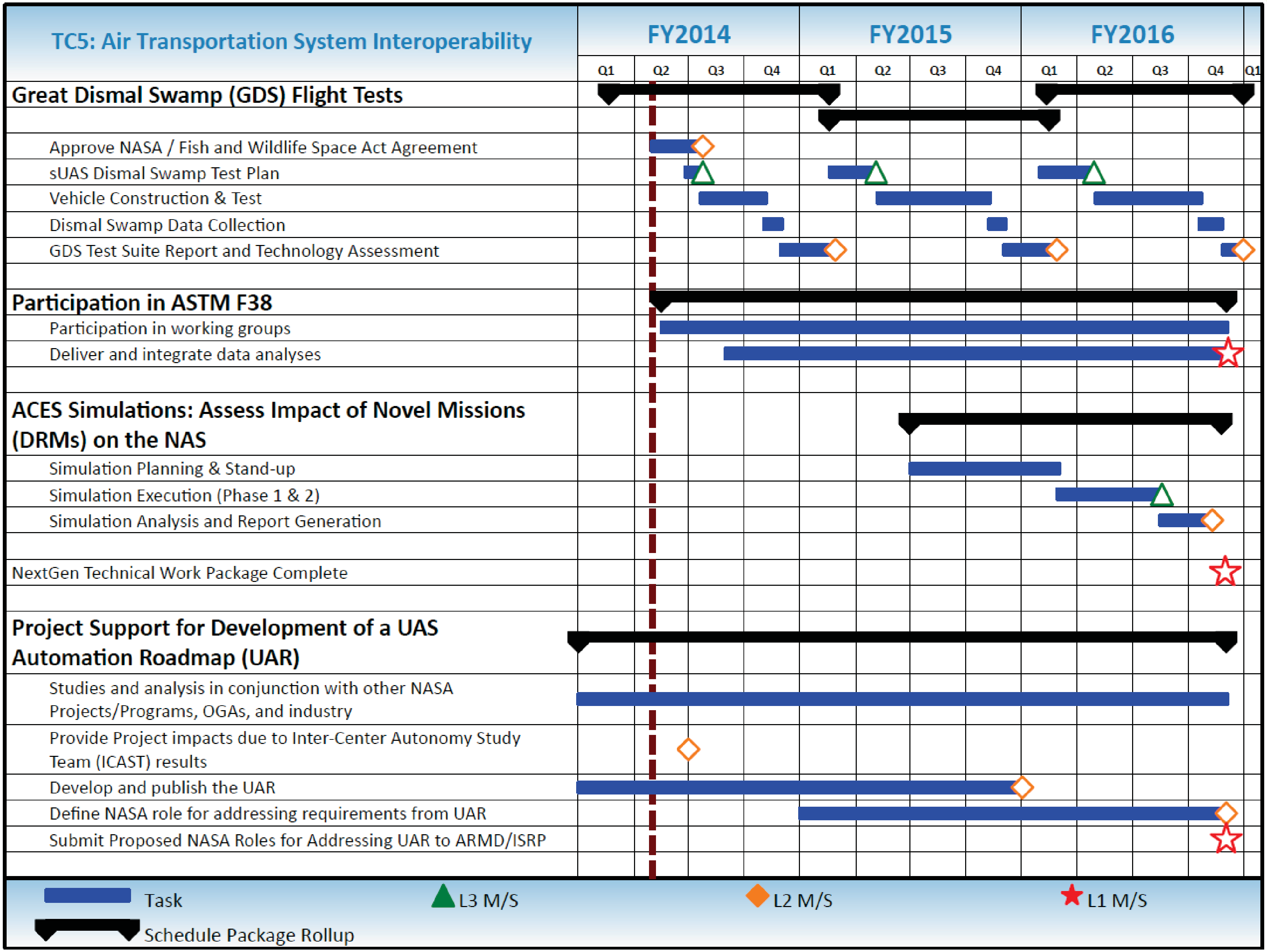
TWP	Plan Briefed at KDP	Proposed Plan
sUAS	Provide the community and regulators with measured data on sUAS component and subsystem reliability rates and measured hazard data of sUAS collisions	Characterize optimal use case of sUAS for fire detection mission; and demonstrate benefits of increasing automation on a specific mission
NextGen	Evaluate the benefit that NextGen procedures and technologies may bring to UAS-NAS integration	Evaluate the benefit that NextGen procedures and autonomy-related technologies that may allow new types of UAS missions and applications (e.g. DRMs)
Autonomy	Provide UAR inputs to JPDO and provide ARMD an assessment of where NASA can uniquely contribute to addressing the community needs for autonomy	Same

TC5: Air Transportation System Interoperability Proposed Changes (cont.)

TWP	Proposed Plan	Impact of Changes
sUAS	Characterize optimal use case of sUAS for fire detection mission; and demonstrate benefits of increasing automation on a specific mission	(+) Increase the understanding of future autonomy scenarios (+) Still provides data to support FAA and ASTM sUAS standards (-) sUAS hazard and reliability data will not be collected and assessed leaving research gaps
NextGen	Evaluate the benefit that NextGen procedures and autonomy-related technologies that may allow new types of UAS missions and applications (e.g. DRMs)	(+) Improves M&S development and understanding of how autonomy will impact the current NAS and future NextGen Air Transportation System (-) Controller interactions for increased levels of UAS into NextGen will not be assessed leading to greater uncertainty of their impact on the future air transportation system

Redesigned with an autonomy focus, while still addressing UAS community needs

UAS-NAS TC5: Air Transportation System Interoperability



KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

Other Project Changes

- UAS-NAS NRA Strategy
  - The Project solicited NRAs that had immediate and substantial impacts in the first three+ years

- NRAs at KDP:
  - University of Michigan: funded in FY13, completes September 2014
  - New Mexico State University (NMSU): funded in FY13, annual options through September 2016

- Propose no NRAs in FY15 and FY16
  - Existing NRA doesn't align well with Project and primary stakeholder goals and objectives
  - Continuing NRA options beyond FY14 does not provide meaningful value to the Project as we focus on specific technology development deliverables
    - Propose to eliminate the NMSU NRA

KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

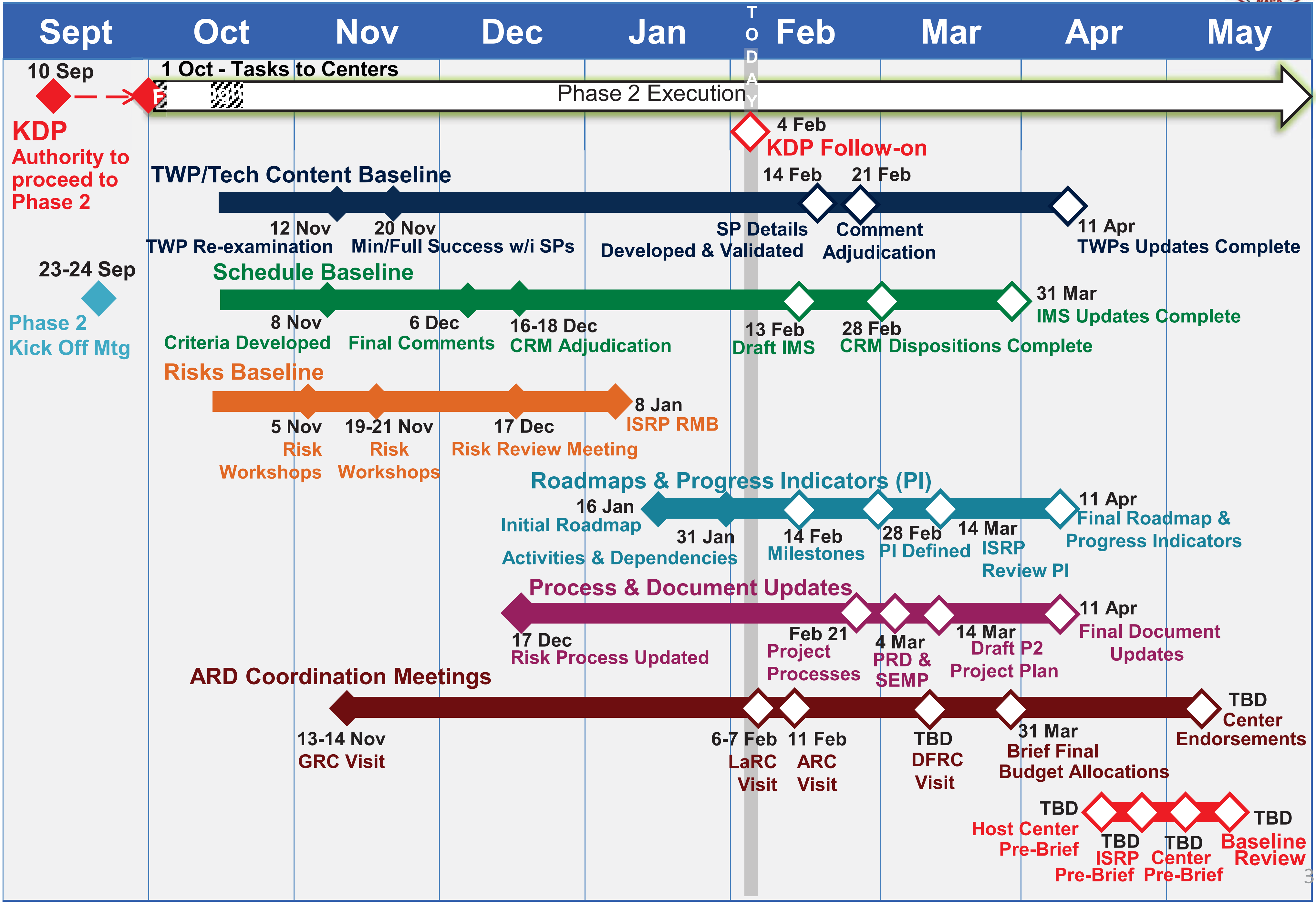
KDP Primary Action Summary

- ✓ More robust TC6
  - Developed high confidence resource loaded TC6 schedule
  - Confirmed TC6 requirements meet research needs for integrated events
  - Confirmed residual risks are acceptable
  - Project reserves have been allocated to account for identified risks and mitigations
  - Redirected funds saved from the redesign of TC4 and TC5 to make TC6 more robust
- ✓ Redesign TC4 and TC5 and descope
  - TC4 reduced the NASA costs by conducting one study and adding a funded partnership
  - Aligned TC5 with future autonomous work
  - TC5 reduced costs in NextGen and sUAS TWPs

KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

Baseline Review Overview Schedule



KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- KDP Primary Action Summary
- Road to Baseline Review
- LVC-DE Enhancements
- Briefing Summary

LVC-DE Enhancements Approach

- KDP Action: *LVC-DE Enhancements Secondary Action*
  - After ensuring that there are sufficient funds to meet current TC6 objectives, if additional funds are available in FY14 and FY15, look at what mods could be made to the LVC-DE to be of better use for future autonomous work
  - The focus should be on setting up an environment that brings in partners for future work (e.g. Zee Aero, Aurora Flight Sciences, FAA UAS Test Sites)
- Approach
  - Collaborate with ASP to identify LVC-DE uses for ASP experiments to address higher levels of Autonomy beyond the scope of the UAS-NAS project
  - Assess LVC-DE development for compatibility with ASP potential uses
  - Identify opportunities to integrate ASP autonomy experiments into UAS-NAS Project
- Outcome
  - LVC-DE enhancement proposal developed to support the PPBE16

LVC-DE Enhancements Status

- Post KDP activities to address the action:
  - Formed joint UAS-NAS/CTD Team led by:
    - UAS-NAS Senior Advisor for Unmanned and Autonomous Systems
    - CTD Project Manager
  - Multiple meetings accomplished
    - Identify potential for LVC-DE to be incorporated into Shadow-Mode Assessment using Realistic Technologies for the NAS (SMART-NAS)
    - Assessing compatibility of LVC-DE with evolving SMART-NAS Architecture
    - Initiated discussions with FAA UAS Test Sites
    - Collaboration with ICAST to ensure the LVC-DE will be useful for integrated autonomy research testing
    - Examined briefing materials presented during NRC Committee for Autonomy Research for Civil Aviation (awaiting formal NRC report)
  - ASP visit to DFRC for additional LVC-DE background and to discuss path forward planned

LVC-DE Enhancement Planning Underway

LVC-DE Enhancements Next Steps

- Briefing planned (date TBD) to ARMD presenting schedule and budget for:
  - Options and recommendations and for LVC-DE enhancements
  - UAS-NAS/ASP collaboration opportunities in UAS-NAS integrated flight tests
  - Transition plan to ASP
  - Proposed partnerships with industry and FAA UAS Test Sites

Anticipate that the LVC-DE will provide significant benefits to ARMD for future autonomy related research

KDP Follow-On Outline

- Project Overview & KDP Actions
- More Robust TC6
- Updated TC4
- Updated TC5
- Additional Changes
- LVC-DE Enhancements
- KDP Primary Action Summary
- Road to Baseline Review
- Briefing Summary

KDP Action Summary

- ✓ Ensure TC6 is sufficiently "robust" to execute with a high level of confidence
- ✓ Execution of TC4 and TC5 are pending approval following the completion of the following actions:
  - Redesign TC4 and TC5 and descope
    - If TC4 remains in the portfolio, need to reduce the NASA costs (1 study) AND add a funded partnership
  - Since TC5 matches well with the future work vs. the immediate needs, consider aligning TC5 with future autonomous work
- ✓ Consider Center workforce balance when making the above decisions
- ✓ Come back prior to baseline review to brief the redesigned TC4, TC5, and TC6
- LVC-DE Enhancements Secondary Action *(presented plan forward)*
  - After ensuring that there are sufficient funds to meet current TC6 objectives, redesign of TC4 and TC5, if additional funds are available in FY14 and FY15, look at what mods could be made to the LVC-DE to be of better use for future autonomous work
  - The focus should be on setting up an environment that brings in partners for future work
  - External partner
    - Look at the possibility of establishing a relationship with ZeeAero or Aurora

KDP Follow-on Decision Request

- KDP Follow-on
  - ✓ Addressed the actions received at KDP

- Decision the Project is seeking today
  - Approval of TC4, TC5, and more robust TC6
  - Approval to proceed with the path forward toward identifying future LVC-DE enhancements

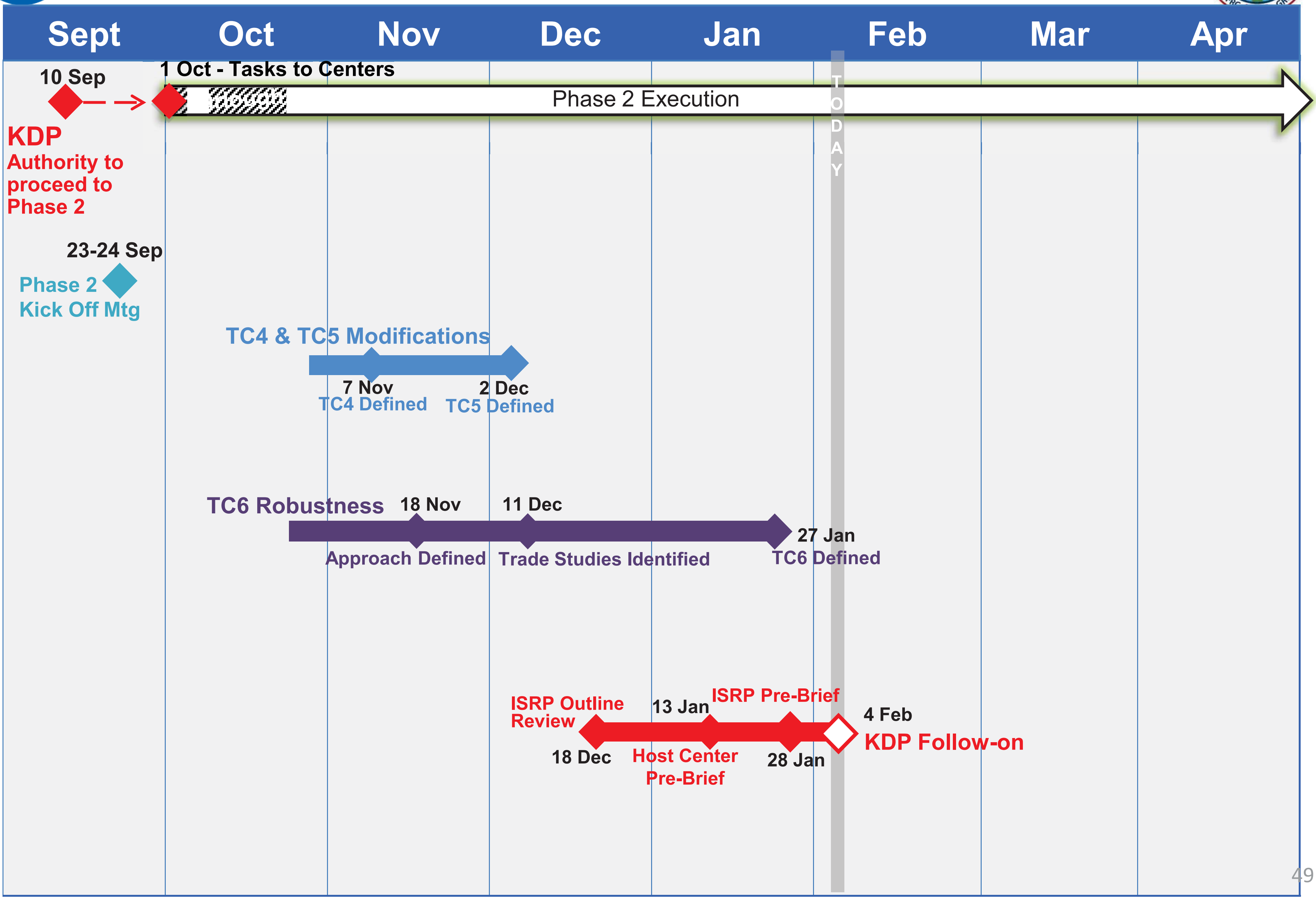
Backup Slides

UAS Integration in the NAS Project

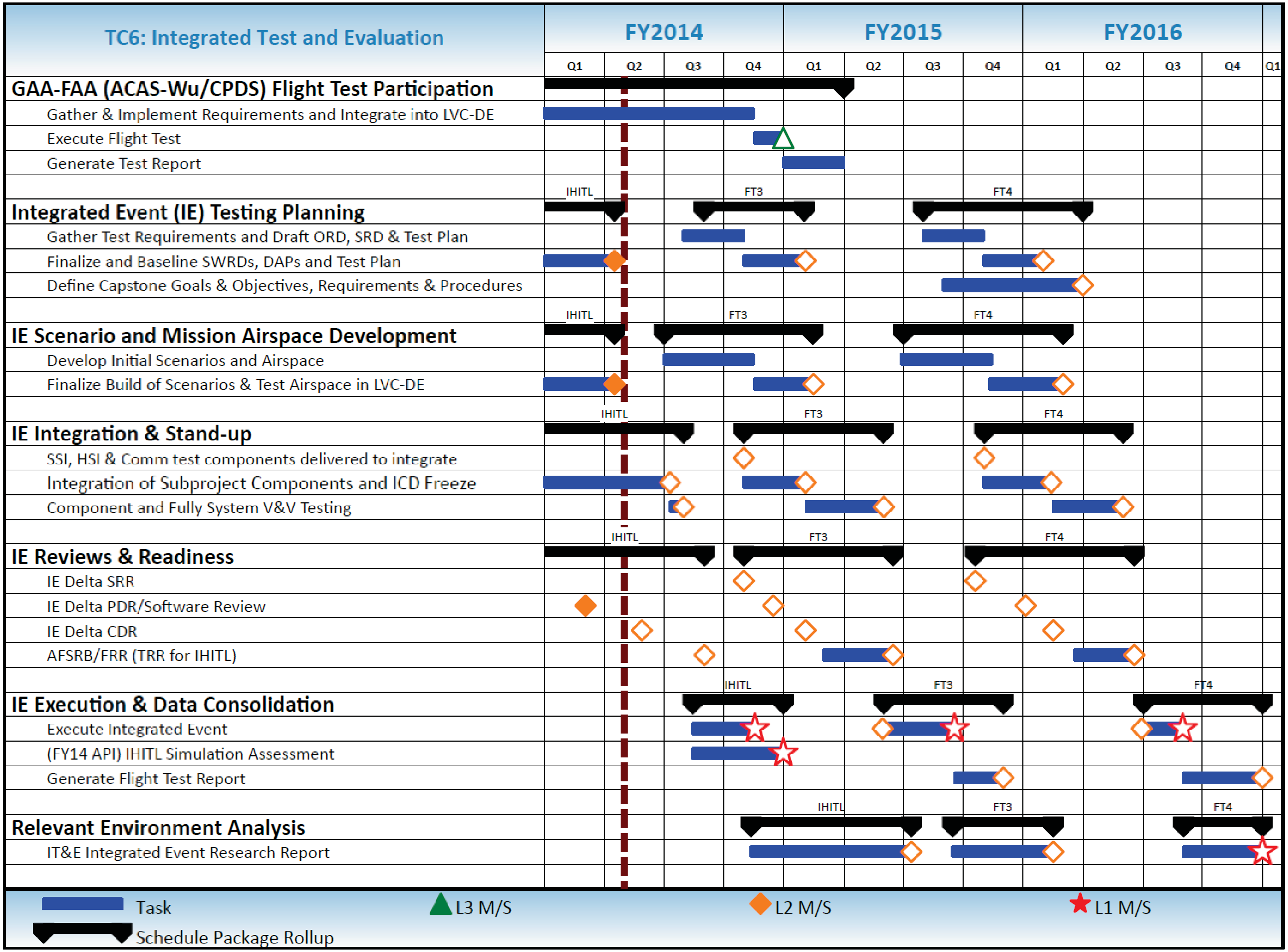
Tech Challenges - Products – Outcomes – Stakeholder Engagement

Technical Challenges	Key Products	Resultant Outcomes	Stakeholder Engagements
TC1 SAA Performance Standards	*SAA Performance Requirements to inform DAA MOPS*	RTCA DAA MOPS → SAA Technical Standard Order (TSO)	• *Participating in SC-228 DAA Working Group & Standards Development* • *Participant in FAA SAA workshop* • *Active member of OSD SAA SARP* • *Working closely with AFRL SAA efforts*
TC2 C2 Performance Standards	*C2 Performance Requirements to inform C2 MOPS*	RTCA C2 MOPS → C2 Technical Standard Order (TSO)	• *Participating in SC-228 C2 Working Group & Standards Development* • *Cost-share with Rockwell Collins* • *Active participant in World Radio-Communications (WRC)*
TC3 Human Systems Integration	*SC-228 GCS & HF Whitepapers*	RTCA DAA MOPS, RTCA C2 MOPS → SAA Technical Standard Order (TSO), C2 Technical Standard Order (TSO)	• *Participating in SC-228 DAA & C2 Working Group & Standards Development* • *Collaborating with AFRL, Universities and Industry* • *Leveraging FAA air traffic controllers*
TC4 Certification and Safety	*Safety Substantiation Final Report & Safety Metrics Data*	Restricted Category Certification Guidance	• *Potential cost-share with industry* • *Engaging with UAS EXCOM on UAS certification and safety*
TC5 Air Transportation System Interoperability	*ATS Interoperability Study Results* *sUAS Data Analysis Results* *Inputs to the UAS Automation Roadmap*	F38 sUAS Standard, UAS Auto. Roadmap → FAA UAS Policies & Procedures, FAA UAS Rules & Regulations	• *Collaborating with JPDO on NextGen Concepts* • *Assisting JPDO with UAS Automation Roadmap* • *Participating in ASTM F38 Small UAS Standards Development activities* • *Engaging with UAS Aviation Rulemaking Committee (ARC)*
TC6 Integrated Test and Evaluation	*Re-usable Test Infrastructure* *Test Data to support SAA & C2 Standards Devlpmt*	RTCA DAA MOPS, RTCA C2 MOPS → SAA Technical Standard Order (TSO), C2 Technical Standard Order (TSO)	• *Collaborating with FAA UAS Program Office and FAA Tech Center* • *Participating in SC-228 DAA & C2 Working Group & Standards Development*

KDP Follow-On Review Schedule



UAS-NAS TC6: Integrated Test and Evaluation



Risk Reduction Activities

KDP briefing did not show the existing intermediate risk reduction testing that enhances confidence in the successful completion of integrated tests. These include:

- Risk reduction activities for IHITL
  - Full Mission Simulation 1: Airspace development, delivery of algorithms, and prototype integration into LVC
  - Part-Task Simulation 4: Scenario build-up and final delivery of AutoResolver algorithm
  - UAS CAS1: Airspace and scenario development
  - Simulation Voice Comm Latency Testing
    - Test candidate digital voice connection between Ames and Dryden
    - Test digital to analog communication between Ames and Dryden
- Risk reduction activities for Flight Test Series 3
  - Gen2 Radio in Relevant Environment: Characterize timing of link between radio and LVC
  - Aircraft check-out of LVC Connection
    - Measure timing of ADS-B link to LVC
    - Measure timing of telemetry link
    - Test T-34 connection to RGCS HSI Displays (Vigilant Spirit) via VPN directly with GRC
- Risk reduction activities for Flight Test Series 4
  - Verify Communication System Performance: Test Comm link with multiple aircraft

Risk Reduction Activities (cont.)

Identified new risk reduction activities:

- Risk reduction activities for GA-FAA (ACAS-Xu) Flight Test Participation
  - Establish IT connection between GA and LVC
  - Develop GA GCS ICD
  - Integrate SSI algorithms into LVC
  - Support test procedure writing
  - V&V testing of LVC component
- Risk reduction activities for Flight Test Series 3
  - Aircraft check-out
- Add travel for IT&E to witness sub-project simulations
  - UAS-Controller Acceptability Study (CAS) 1 at Langley

“Checklists” = List of deliverables provided by other Sub-Projects to IT&E

- IT&E has a series of tasks included in the IHITL (TWP 27) schedule that are included as a way to communicate to the other SubProjects where deliverables (information/inputs) are needed to proceed with IHITL buildup/integration.
  - These tasks hold “checklists”. The “checklists” are lists of specific information/inputs, or deliverables to IT&E, that are needed from the other SubProjects.
  - The items on the “checklists” are a recommended method to generate a linkage to the other SubProject schedules that corresponds with providing the deliverable to IT&E.
  - This new deliverable would then be linked as a predecessor to the IT&E task that holds the “checklist”.
- The following charts are the IT&E tasks that need predecessor linkages generated to the other SubProject schedules to provide the deliverables listed on the “checklist”.
  - Each “Checklist” item, or deliverable, has a responsible PE and their respective Sub-Project identified.
- Checklists Items then have an associated schedule item within the relevant TC

- “Checklist”/deliverables associated with this IT&E task:
  - ❑ LVC Gateway Updates (Jim Murphy-IT&E)
  - ❑ CSD (Jay Shively-HSI)
  - ❑ Common MACS Version (Eric Mueller-SSI)
  - ❑ ADRS (Jim Murphy-IT&E)
  - ❑ LaRC Version of MACS (Maria Consiglio-SSI)
  - ❑ VSCS (Jay Shively-ARC)
  - ❑ Voice Comm (Jim Murphy & Sam Kim-IT&E)
  - ❑ SAA Algorithms (Eric Mueller-SSI)
  - ❑ SAA Proc (Jim Murphy-IT&E)
  - ❑ CNPC Delay Model (Jim Griner-Comm)
  - ❑ Version Description Document (VDD) for SAA Algorithm (Eric Mueller-SSI)
  - ❑ Version Description Document (VDD) for MACS GCS (Maria Consiglio-SSI)
  - ❑ Version Description Document (VDD) for MACS (Eric Mueller-SSI)
  - ❑ Version Description Document (VDD) for Vigilant Spirit (Jay Shively-HSI)
  - ❑ Version Description Document (VDD) for CSD (Jay Shively-HSI)

Schedule Updates

Generate resource loaded, high confidence schedules for IHITL, ACAS-Xu, YO-3, FT3, and FT4

- High confidence, resource loaded IHITL schedule completed
  - Added fidelity and confidence to the tasks and has been approved by DFRC
- Proposed “Internal Milestones” be incorporated into the UAS-NAS Project IMS as opposed to the entire IHITL schedule. “Internal Milestones” are:
  - Project Milestones (i.e. Level 1 / 2 milestones)
  - Deliverables needed from outside DFRC
  - Major Reviews
- Deliverable “Internal Milestones” details tracked via checklists within CCPM
  - The “Internal Milestone” approach is meant to communicate a need date to PEs and DPMfs
  - IT&E PEs to vet checklists with deliverable owners to ensure the list is complete and agreed to
- Currently developing FT-3, FT-4, ACAS-Xu & YO-3 (Intruder) Schedules:
  - Will start with the framework of the IHITL schedule when creating FT-3 and FT-4 schedules
  - Expected to be complete by end of January
- Plan to have a schedule summit meeting in February to review schedules with other subprojects to ensure linkages are consistent with expectations

Revisit DFRC Pre-KDP Independent Assessment of IT&E

- Pre-KDP DFRC performed a review of IT&E Technical Work Packages (TWP)
  - Objective: Determine DFRC's ability to support project execution times (schedule, tasks, subtasks) with resource and asset estimates (FTW, WYE, procurement) and risks (TWP risk and mitigations) identified.
  - Conclusion:
    - Based on the current content of the TWPs, there is a need to further define project details and dependencies in order to successfully execute the current set of TWPs.
    - **Medium+** risk based on dependencies not being identified or developed.

- After reviewing the Post-KDP IT&E updates already made and planned the Risk was re-assessed as **Low+** based on:
  - Addition of a full-time PM
  - Addition of a part-time Risk Manager
  - Additional resources where needed
  - Development of the Project Plan almost complete
  - Risk Management Plan completed and more detail added to the mitigation plans
  - CCPM networks completed for iHITL and in-work for FT3 & FT4
    - Adding Internal Milestones to identify deliverables
- Recommendation:
  - Definitely keep an eye on the integrated schedule and costs, but the team is taking actions to do this and if issues arise should be able to respond early enough to take corrective actions.

TC4: Certification and Safety Background

- Community Need Addressed
  - Airworthiness certification standards and requirements to operate commercially in the NAS (for UAS > 55lbs or beyond line of sight)
    - Supports FAA's Integration of UAS into the NAS, Concept Level Requirements, v1.0, 31 October 2014:
      - FAA Requirement 4.1.1-27: "The FAA shall, in collaboration with industry, develop and/or adapt airworthiness requirements specific to UAS on which to base type certification"
      - UAS Operator Requirement 4.1.2-1: "Civil UAS operators shall obtain an appropriate airworthiness certificate from the FAA before operating in the NAS"
    - Addresses specific design and performance criteria (e.g., "standards for reliability of critical systems and functions") for different UAS types and operations (per FAA Requirement 4.1.2-11)
  - Improved methods for safety substantiation per WBS 1.1.2.4 "Determine how safety should be substantiated" from UAS ARC Implementation Plan, 1 March 2013
  - Studies to develop design criteria handbook for rotorcraft per WBS 1.1.1.3 of UAS ARC Implementation Plan (consistent with JPDO UAS Roadmap)

- SOA Prior to UAS-NAS Project
  - No defined airworthiness certification standards, requirements, or processes exist for commercial UAS
  - Extreme cost of existing safety assessment and substantiation processes is a significant barrier. Alternatives have been proposed, but not validated in context or adopted

TC4: Certification and Safety Tasks and Primary Roles

Major Tasks	NASA/UND Role
Develop detailed concept of operations for precision agriculture operation - UAS performance and functional requirements and operational environment	Joint, leveraging UND connection to precision agricultural community
Acquire UAS design that satisfies precision agriculture CONOPS	UND lead, based on CONOPS requirements
Develop the type certification basis for that UAS design, assuming restricted category	NASA lead
Develop and evaluate alternate means of safety substantiation argument-based safety cases	NASA lead
Assess applicability to similar UAS types doing the same operation	NASA lead
Assess applicability to related operations	NASA lead
Report on the type certification basis (including design and performance criteria), applicability and related analyses, and evaluation of safety substantiation	NASA lead

TC4: Certification and Safety Overview

Description: Conduct case study to develop safety substantiation data for a type certificate (restricted category) for a UAS platform performing a commercial precision agriculture operation.

Objectives

Objectives:

- Develop UAS design and performance criteria necessary for airworthiness certification (restricted category) for a UAS platform for precision agriculture.
- Evaluate an alternative approach for developing safety substantiation data for a UAS.

Benefit to the Community:

- Helps enable commercial operations within CONUS for UAS with no prior military approvals.
  - helps enable an emerging industry
- Helps define the standards/ procedures/processes for UAS airworthiness certification necessary for routine operations.
- Provides example of airworthiness certification expectations and acceptable design and performance criteria.

Approach

Approach:

- Determine airworthiness requirements for a UAS doing a precision agriculture application.
  - Define the concepts of operations for an unmanned precision agriculture application
  - Develop type design requirements and operational limitations for that UAS
  - Analyze safety data to discern generalized applicability to other UAS
  - Capture safety substantiation data using two different approaches to study suitability

Key Collaborators & Formal Partners:

- Partner: University of North Dakota

Success Criteria:

- Deliver recommendations for UAS design and performance criteria that would satisfy airworthiness requirements for a UAS platform, doing precision agriculture in a defined context.
- Recommend an approach to safety substantiation for UAS.

Deliverables

Deliverables:

- UAS design and performance criteria report
- Safety Substantiation report.
- Applicability to other UAS and other operations report

Plans for Use:

- FAA UAS Integration Office will use results to support the development of regulatory standards and guidance for UAS Certification.
- UAS industry will learn about certification processes and expectations.
- Inform new Part 23 process.

Technology Transfer Method:.

- Formal: Delivery of product to FAA and North Dakota UAS Test Site.
- Informal: Meetings and discussions with collaborators and partners.
- Publication of the type certification basis and applicability of results to other UAS and operations.

TC4: Certification and Safety Task Flow

Case Study Definition and Platform/Data Acquisition

Define Precision Agriculture Concept:
- Functional requirements
- Use/Business Cases

➢ *UND Lead*

Elaborate Operational Context:
- Classes of Airspace
- Air Route Structure
- Air Traffic Characteristics
- Procedures/Infrastructure
- Natural Environment

➢ *Joint NASA-UND*

Acquire UAS Data
- Architecture
- Design
- Functional Capabilities
- Performance
- Equipage

➢ *UND Lead*

Type Certification Development & Alternative Approach

Develop Conventional Type Certification Basis
- UAS design and performance requirements
- Operational limitations

➢ *NASA LaRC Lead*

Argument-based Safety Case
- Safety argument for design, based on the type cert findings

➢ *NASA Ames Lead*

Analysis

Applicability Analysis
- Evaluate applicability of results to
  - different UAS
  - other operations

➢ *NASA LaRC Lead*

Safety Substantiation Analysis
- Evaluate argument-based approach versus conventional

➢ *NASA Ames Lead*

Products

Report on UAS Design and Performance Criteria for Airworthiness Certification

Report on Safety Substantiation Approaches

Report on Applicability to Other UAS and Other Operations

NASA/UND collaboration greatly increases the realism of the type certification study and robustness of the analysis

TC4: Certification and Safety Applicability Analysis

Products from Development of Type Certification Basis

- Issue Papers
- Special Conditions
- Equivalent Level of Safety
- Hazard/Risk Analysis

(Proposed)
TYPE CERTIFICATION BASIS

Model Description

Flight Limitations

Certification Basis

Location of Operation

Aircraft-Centric Analysis

- How does the proposed type certification basis differ from existing airworthiness standards?
- What are implications to certification processes and the class/ category framework? (including new Part 23)
- Could this basis apply to other UAS, doing the same operation in the same context?
- What design assumptions and means of compliance could be answered or validated by flight test?

Report on UAS Design and Performance Criteria for Airworthiness Certification

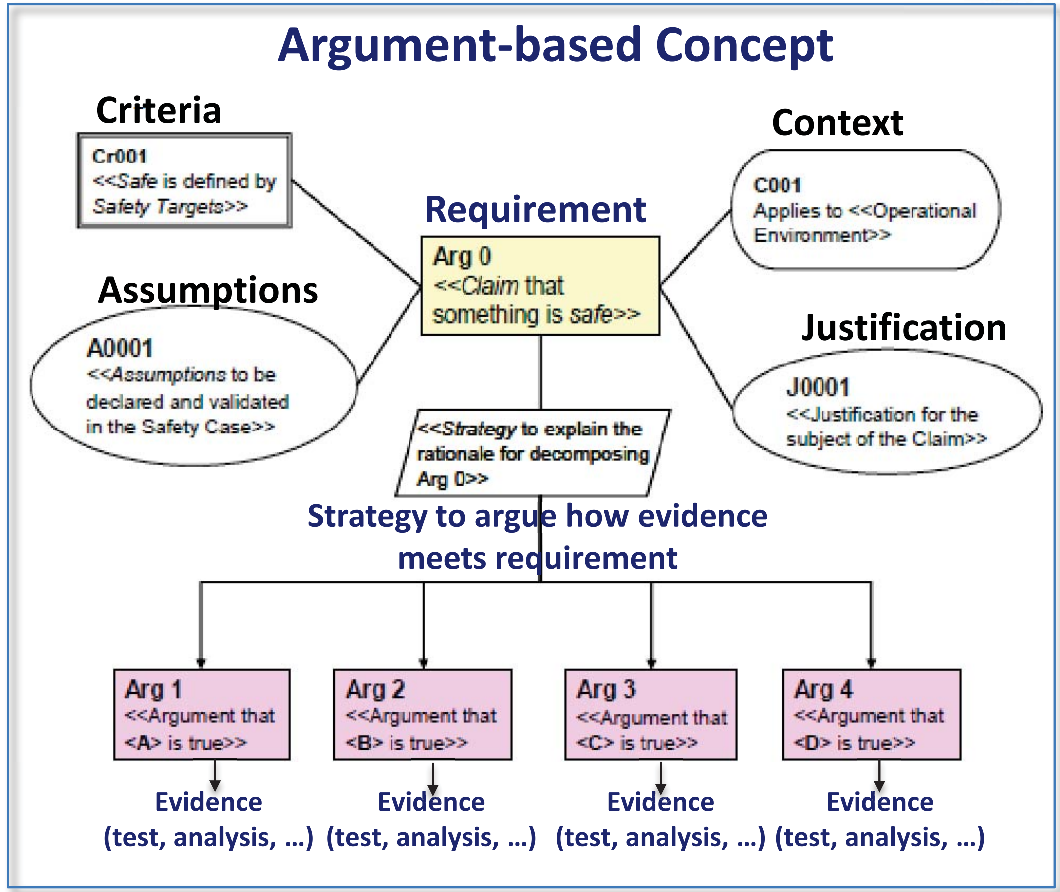
Operations-Centric Analysis

- Could this basis apply to the same UAS doing the same operation in a different but related context?
- Could this basis apply to other operations, using the same UAS in the same context?
- How do the hazards/risks and design and performance criteria change if the UAS is autonomous instead of remotely-piloted?

Report on Applicability to Other UAS and Other Operations

TC4: Certification and Safety
Safety Substantiation Analysis

- Apply argument-based safety cases (from AvSP) to UAS safety substantiation
  - systematic, structured approach to documenting the relationship between safety requirements and evidence of safety
- Use data from type certification basis to argue that the type design is safe
  - define evidence needed to demonstrate safety (from flight tests, analysis, etc.)
- Apply lessons learned from other UAS safety cases, as possible (Swift, Sierra, Triton)



- Determine if the argument-based approach identifies airworthiness requirements beyond conventional type certification basis
- Evaluate the efficacy of safety substantiation methods (conventional vs. argument-based)
- Report lessons learned and evaluation results

Report on Safety Substantiation Approaches

TC4: Certification and Safety
Type Certification Basis Work

- Identifies applicable airworthiness standards and noise and environmental regulations
  - driven by hazard identification and risk analysis for the UAS
  - addresses standards from 14CFR and guidance for UAS; e.g.,

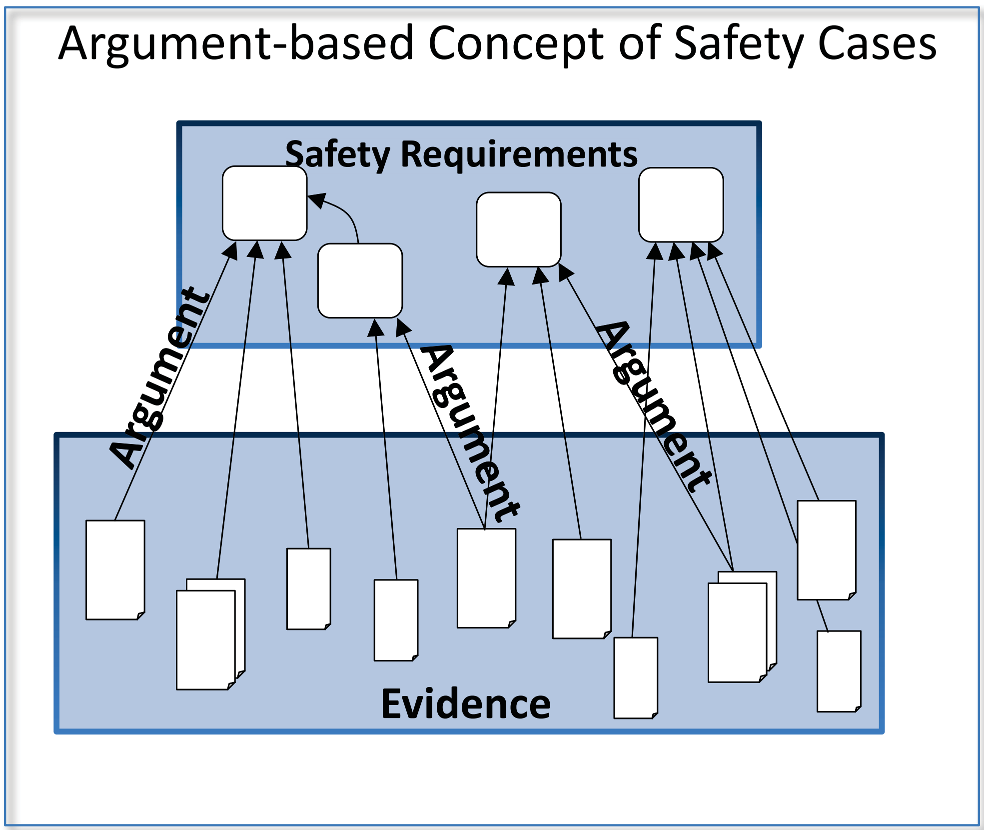
Part 21	Certification Procedures for Products and Parts
Part 23 & 27	Airworthiness Standards
Part 33	Aircraft Engines Standards
Part 36	Noise Standards
Part 91	General Operating and Flight Rules
Part 137	Agricultural Aircraft Operations
FAA Orders/Notices	UAS airworthiness & operational approval (O 8130.34B, N 8900.207)

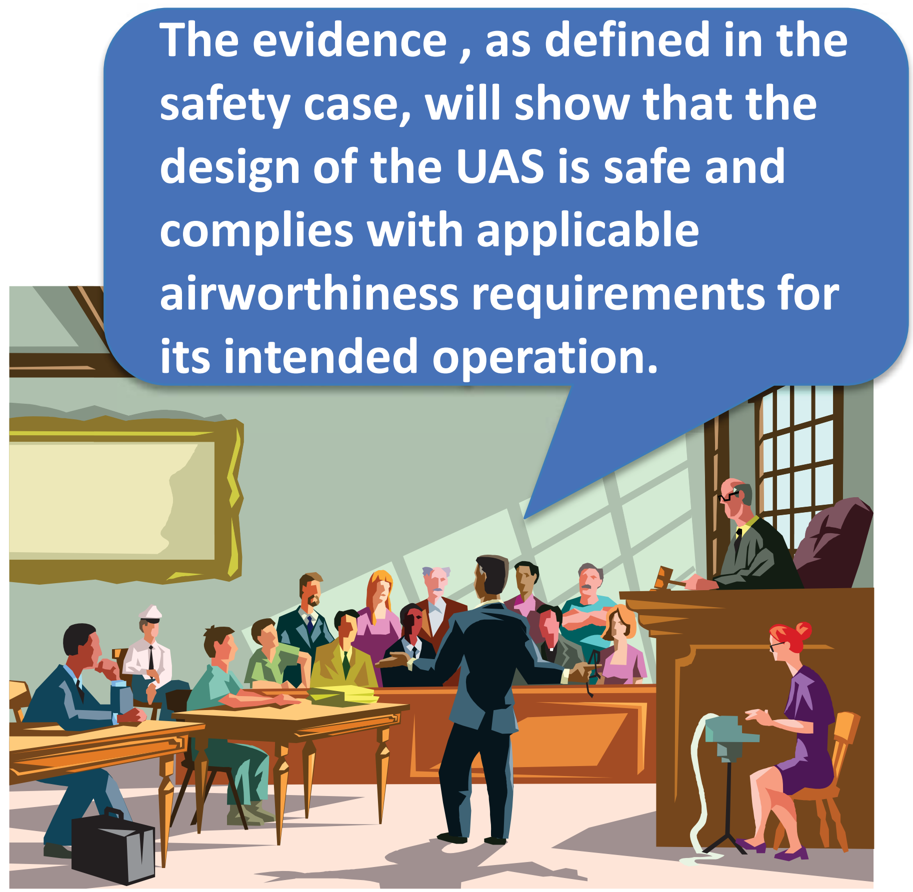
JARUS Certification Specification for Light Unmanned Rotorcraft Systems

- Identifies special conditions, exemptions, and equivalent safety findings
  - provides rationale for design aspects that are different from the norm (e.g., composite wing and fuel tank structure for B787)
    - for UAS, there is no norm; but, rationale is still prudent
- Identifies issues relevant to special requirements needing resolution
  - identifies issues where further work is needed, or novel features that have not previously been addressed by any standard/regulation/policy (e.g., for ground control stations)
- *Type Certification is typically required as part of civil airworthiness certification*
  - *UAS with prior military approval can be exempted (e.g., Scan Eagle and Puma)*

TC4: Certification and Safety
Safety Substantiation

- Apply research in argument-based safety cases from the Aviation Safety Program to safety substantiation of unmanned aircraft in ISRP
- Argument-based safety cases provide a systematic, structured approach to documenting the relationship between safety requirements and evidence of safety
  - based on the notion of a legal argument
  - the argument explains how/why the evidence satisfies the requirements





TC5: Air Transportation System Interoperability Overview

Description: Develop requirements for an UAS Automation Roadmap, study concepts and technologies developed for NextGen and their application to UAS, examine autonomous self separation for all UAS in all airspace classes, and collect specific data relevant to partner Agencies while conducting high-value sUAS missions utilizing increasing levels of autonomy and sUAS technologies.

Objectives

Objectives:

- Provide UAR Inputs to the JPDO and provide to ARMD an assessment of where NASA can provide unique contributions to address the community needs for autonomy.
- Evaluate autonomy-related technologies and procedures that may allow new types of UAS missions and applications (e.g. DRMs).
- Design/build/fly increasingly more complex aircraft for a specific mission while characterizing sUAS performance and ASTM standards
- Characterize optimal use case of sUAS for fire detection mission; and demonstrate benefits of increasing automation on a specific mission.

Benefit to the Community:

- A UAR will help enable increased level of automation including reduced crew operations and ultimately fully autonomous operations.
- Better understanding of NextGen capabilities will contribute to UAS integration and may allow UAS operators to develop systems compatible with NextGen technologies.
- Development of processes, procedures, and demonstrate safety through examination of reliability and performance data from actual Class G operations with sUAS.

Approach

Approach:

- Collaborate with NASA Programs/Projects, NASA Centers, and the community of interest to determine requirements for the UAR and appropriate NASA contributions.
- Conduct fast-time simulations to study the benefits of NextGen technologies and procedures, including increased reliance on autonomy, on UAS-NAS integration.
- Collect and analyze studies/materials on varying levels of autonomy/automation.
- Build and fly sUAS to characterize key aircraft and mission parameters; and participate in ASTM F38 standards development.

Key Collaborators:

- ASTM F38,US Army, FAA UAS Integration Office, JPDO, US Fish and Wildlife Service (USFWS)

Success Criteria:

- Development of the UAR.
- Evaluation of ICAST design reference missions (DRM)
- Develop sensor data requirements for USFWS specific to sUAS fire detection mission.
- Develop sUAS autonomy requirements for varying levels of automation

Deliverables

Deliverables:

- Comprehensive UAR and NASA advocacy package
- Analysis and simulation results
- UAS Performance Models and Scenarios
- Annual Mission Analysis and Technology Assessment Reports
- ASTM F38 Standards review and recommendations

Plans for Use:

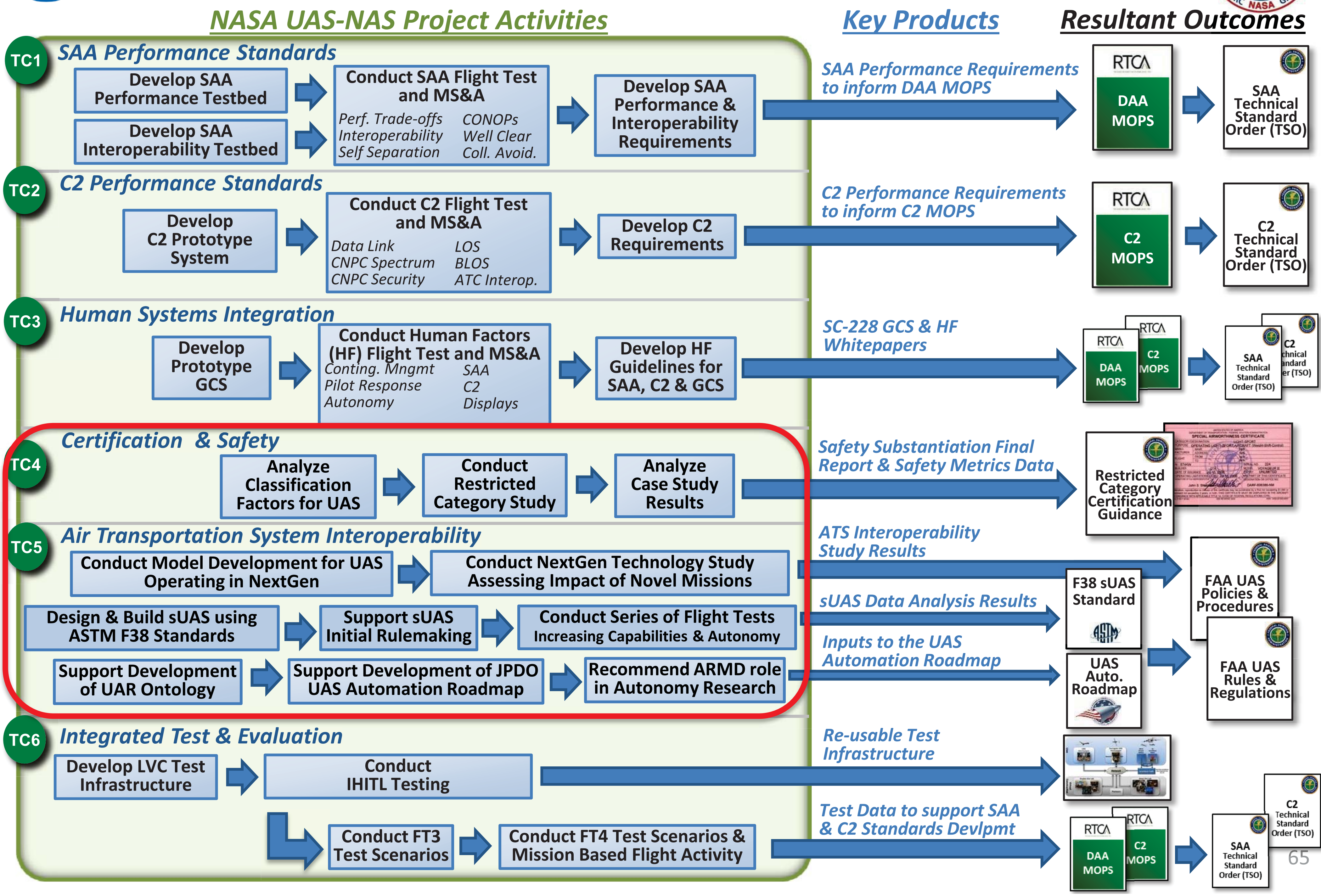
- JPDO may use the results to guide roadmaps for UAS integration as a function of expected NextGen technologies.
- FAA may use these results to augment the justification for deploying certain technologies and procedures.
- USFWS data package used to develop advocacy and acquisition of sUAS systems

Technology Transfer Method:.

- Informal: Active participation in meetings within the community.
- Formal: Deliveries of results, analysis, documentation to stakeholders.

UAS Integration in the NAS Project

Value Proposition Flow Diagram



Phase 2 Content Maturation
Developing a Baseline

- Baseline review preparation for TCs 1, 2, 3 and 6 in work. Preparation for the rest of the portfolio is pending approval at the KDP Follow-on meeting

- Currently defining the approach to mature the Phase 2 content and generate Project baseline. Also identifying the timeline to implement that approach.
  - Approach will minimize impact to PEs
  - Timeline to implement will allow for Baseline Review scheduling

- Baseline development activities include (see next slide for details):
  - Re-examine the risks
  - Re-examine the schedule
  - Re-examine all TWPs
  - Re-examine project execution processes
  - Generate Phase 2 project level documents

- Baseline development participants:
  - Project Office and DPMfs will conduct the reviews of the risks, IMS, and TWPs to identify issues and questions
  - Work with the PEs to address the concerns

Phase 2 Content Maturation
Developing a Baseline

- Re-examine the risks
  - Goal: To have a well defined set of risks that is consistent with the Phase 2 content, with descriptive titles and risk statements, detailed mitigations, and well defined impacts.
  - Planned Activities include: Conducting risk workshops to mature the risks and identify any additional risks.
- Re-examine the schedule
  - Goal: To have an Integrated Master Schedule that captures:
    - The Phase 2 activities and deliverables/products with sufficient detail and margin to facilitate the Project's ability to meet it's commitments.
    - All the inputs/outputs/dependencies for the Phase 2 activities including internal, i.e. within the Project/between Subprojects, and external deliveries.
  - Planned Activities Include: Full and complete review of the IMS. Examine milestones and predecessors, deliverables, dependencies, develop progress indicators, etc. Identify inconsistencies, holes, etc.
- Re-examine technical content in all TWPs
  - Goal: To have Technical Work Packages that have a well defined approach:
    - With sufficient detail such that it can be baselined with a well understood plan.
    - Provides insight into why the planned tasks/activities are necessary for the successful completion of the TWP.
  - Planned Activities Include: Requirements review, define minimum & full success within TWPs, assessment of how TWP outcomes collaborate to provide needed results for customers/stakeholders
    - Note: This assessment may feed into the risk and schedule items as well

Phase 2 Content Maturation
Developing a Baseline

- Re-examine Project execution processes
  - Goal: To have thorough set of processes to effectively manage the project.
  - Planned Activities include: Updates to risk, change, schedule, and technical management, processes. Also include updated roles, responsibilities, and expectations for significant team positions.
- Generate Phase 2 Project level documents
  - Goal: To have project level documentation that accurately reflects the project execution and portfolio for Phase 2
  - Planned Activities Include: Generating a Phase 2 Project Plan, Systems Engineering Management Plan, and System Requirements Document
- Finalize the budget the based on all Phase 2 Content Maturation activities
  - Goal: Balance the budget across the centers, subprojects, etc
  - Planned Activities Include: Re-examination of the resources/roll up of the individual TWPs, align with N2 FTE allocations in FY14, ensure compliance with FY15 & FY16 totals, feed results into PPBE cycle

Acronyms

ABSAA	Airborne Sense and Avoid
ACAS	Airborne Collision Avoidance System
ACES	Airspace Concept Evaluation System
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-R	Automatic Dependent Surveillance-Rebroadcast
AFRL	Air Force Research Lab
AFSRB	Airworthiness and Flight Safety Review Board
AOPA	Aircraft Owners and Pilots Association
ARC	Ames Research Center/Aviation Rule Making Committee
ARD	Aeronautics Research Director
ARMD	Aeronautics Research Mission Directorate
ASTM	American Society for Testing Materials
ASP	Airspace Systems Program
ATC	Air Traffic Controller
ATO	Authorization to Operate
ATSI	Air Transportation System Interoperability
AUVSI	Association for Unmanned Vehicle Systems International
AvSP	Aviation Safety Program
BLOS	Beyond Line of Sight
C2	Command and Control
CA	Collision Avoidance

Acronyms

CDR	Critical Design Review
CFR	Code of Federal Regulations
CNPC	Control and Non-Payload Communications
CONUS	Continental United States
CRM	Comment Resolution Matrix
CTD	Concepts and Technology Development
C-UAS	Center for UAS
DAA	Detect and Avoid
DFRC	Dryden Flight Research Center
DOI	Department of the Interior
DPMf	Deputy Project Manager for
DRM	Design Reference Mission
ExCom	UAS Executive Committee
FAA	Federal Aviation Administration
FDR	Final Design Review
FT	Flight Test
FTE	Full Time Equivalent
FY	Fiscal Year
GA-ASI	General Atomics Aeronautical Systems Inc.
GCS	Ground Control Station
GRC	Glenn Research Center
HITL	Human-In-The-Loop

Acronyms

HSI	Human Systems Integration Subproject
ICAST	Inter Center Autonomy Study Team
ICD	Interface Control Document
IHITL	Integrated Human-In-The-Loop
IMS	Integrated Master Schedule
ISRP	Integrated Systems Research Program
IT&E	Integrated Test and Evaluation Subproject
JPDO	Joint Planning and Development Office
KDP	Key Decision Point
LaRC	Langley Research Center
LOS	Line of Sight
LVC	Live Virtual Constructive
LVC-DE	Live Virtual Constructive Distributed Environment
MOA	Memorandum of Agreement
MOPS	Minimum Operational Performance Standards
NAS	National Airspace System
NRC	National Research Council
NMSU	New Mexico State University
NSF	National Science Foundation
NTSB	National Transportation Safety Board
OGA	Other Government Agency

Acronyms

Ops	Operations
OSD	Office of the Secretary of Defense
P1	Phase 1
P2	Phase 2
PE/Co-PE	Project Engineer/Co-Project Engineer
PMR	Project Management Review
PPBE	Planning Programming Budgeting and Execution
PRD	Project Requirements Document
R&D	Research & Development
RFI	Request for Information
RGCS	Research GCS
RTCA SC	RTCA Special Committee
SA	Situational Awareness/Separation Assurance
SAA	Sense and Avoid
SAA-TCAS	Sense and Avoid-Traffic Alert and Collision Avoidance System
SARP	Science and Research Panel
SEMP	System Engineering Management Plan
SGT	Stinger Ghaffarian Technologies, Inc.
SOA	State of Art
SRR	System Requirements Review
SSI	Separation Assurance/Sense and Avoid Interoperability Subproject

Acronyms

sUAS	small Unmanned Aircraft System
SWRR	Software Requirements Review
TBD	To Be Determined
TC	Technical Challenge
TCAS	Traffic Alert and Collision Avoidance System
TIS-B	Traffic Information Service Broadcast
TOR	Terms of Reference
TRR	Test Readiness Review
TWP	Technical Work Package
UA	Unmanned Aircraft
UAR	UAS Automation Roadmap
UAS	Unmanned Aircraft Systems
UAS CAS1	UAS Controller Acceptability Study
UAV	Unmanned Aerial Vehicle
UND	University of North Dakota
US FWS	U.S. Fish and Wildlife Service
VLOS	Visual Line of Sight
V&V	Verification and Validation
WBS	Work Breakdown Structure
WRC	World Radio Conference
WYE	Work Year Equivalent